

Identifying Ghanaian pre-service teachers' readiness for computer use: A Technology Acceptance Model approach

Stephen Adu Gyamfi
University of Lincoln, UK

ABSTRACT

This study extends the technology acceptance model to identify factors that influence technology acceptance among pre-service teachers in Ghana. Data from 380 usable questionnaires were tested against the research model. Utilising the extended technology acceptance model (TAM) as a research framework, the study found that: pre-service teachers' pedagogical beliefs, perceived ease of use, perceived usefulness of computer technology and attitude towards computer use to be significant determinants of actual use of computer technology. Results obtained employing multiple stepwise regression analysis revealed that: (1) pre-service teachers' pedagogical beliefs significantly influenced both perceived ease of use and perceived usefulness, (2) both perceived ease of use and perceived usefulness influence attitude towards computer use and attitude towards computer use significantly influences pre-service teachers' actual use of computers. However, statistically, perceived ease of use did not significantly influence perceived usefulness. The findings contribute to the literature by validating the TAM in the Ghanaian context and provide several prominent implications for the research and practice of technology integration development.

Keywords: *Pedagogical Beliefs, Pre-service teachers, Technology Acceptance Model, Regression Analysis*

INTRODUCTION

The use of computers is becoming widespread in Ghanaian education settings. While the students, especially those in the junior and senior high schools, seem ready to embrace this modern technology, it is not easy to identify a similar readiness in teachers. For example, Adu Gyamfi (2011) in his study on the use of Information and Communication Technology (ICT) on pre-service teacher education in Ghana concluded that about 85 percent of the new teachers graduating from Ghanaian pre-service teacher institutions felt they lacked the necessary skills to teach with ICT, implying an inadequacy in the training of the teachers. However, an accumulating body of research has found that teachers' contribution is very important for the implementation and success of any technological innovation in education (Eteokleous-Grigorous, et al., 2012; Lim, Lock & Brook, 2011). Consequently, teachers' familiarity is crucial for a successful introduction of computer technologies into the classroom environment. Again, in his study in Singapore to build a model that predicts the level of technology acceptance by pre-service teachers at the Institute of Education, Teo (2009) found that, the level of technology acceptance among pre-service teachers determines the extent to which new technologies could be integrated into classroom settings. Given that pre-service teachers are the agents of change in the effective and meaningful integration of computer technology in the Ghanaian education system, their readiness to use this modern technology is of paramount importance. For this reason, there is a need to understand factors that influence technology acceptance among pre-service teachers in Ghana. This study extends the technology acceptance model to identify factors that influence technology acceptance among pre-service teachers in Ghana. The findings contribute to the

literature by validating the TAM in the Ghanaian context and provide several prominent implications for the research and practice of technology integration development.

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

This section encompasses the study's literature review. First, it discusses issues related to pre-service teachers' beliefs about technology acceptance. Second, it addresses the Technology Acceptance Model which provides the conceptual model for the current study.

Beliefs about technology use

Generally, when teachers are asked to use technology to facilitate learning, some degree of change in their beliefs is required (Ertmer & Ottenbreit-Leftwich, 2010). Although, a growing number of research studies have revealed that there are a number of factors such as lack of access to ICT(Ertmer, et al.,1999), inadequate technical and administrative support (Sandholtz, 2001), lack of training provided to teachers in integrating ICT(Adams,2005; Lim & Khine(2006) most reform efforts in the past have been unsuccessful, because of top-down approaches, which failed to take teachers' existing beliefs into consideration (Hammond, 2011; Jimoyiannis & Komis, 2007). It is against this background that this study is designed to extend the technology acceptance model, by adding pedagogical beliefs to examine factors that influence technology acceptance among pre-service teachers in Ghana.

The pertinence of pedagogical beliefs in educational innovation was captured by Kagan (1992:85) who noted that "the more one reads studies of teacher belief, the more strongly one suspects that this piebald form of personal knowledge lies at the very heart of teaching." In a similar vein, Pajaras (1992) was of the view that understanding teachers beliefs helped improve their professional preparation. This implies that, an understanding of the current beliefs and perspectives that pre-service teachers hold may serve as a good starting point for discussion about their acceptance and adoption of computer technology for instructional purpose.

Pedagogical beliefs are defined as the beliefs that teachers hold, pertaining to the nature of teaching and how teaching should be carried out (Teo, Chai, Hung & Lee 2008). They are broadly grouped into two major categories, namely, traditionally oriented beliefs and constructivist oriented beliefs. Many researchers are of the view that pre-service teachers' pedagogical beliefs and teaching philosophies influence the way that technology is adopted and the degree of technology integration within classroom practices (Chai, Teo, & Lee, 2010; Hung & Lee, 2008). This suggests that the extent to which computers will be accepted and adopted by pre-service teachers depends on the type of pedagogical perspective adopted by these prospective teachers.

Although some researchers such as Lim & Chai, 2008 still do not agree with the above assertion, in general, it is believed that pre-service teachers whose philosophies favour constructivist-oriented beliefs and student-centred approaches are found to be more likely to integrate ICT in their classrooms in a substantial and intellectually fruitful way (Jimoyiannis et al 2007; Judson, 2006). According to Duffy and Cunningham (1996:177) constructivist belief is belief that "learning is an active process of constructing rather than acquiring knowledge" and that "instruction is a process of supporting that construction rather than communicating knowledge. For example, Judson (2006) noted that teachers who adopt constructivist instructional models use computer technology, both frequently and in a more advanced capacity, than those who have not. Conversely, teachers with more traditional pedagogical beliefs are found to implement more traditional or "low-level" technology uses. Hermans, Tondeur, van Braak & Valcke (2008:1499) noted that "traditional beliefs had a negative impact on integrated use of computer technology." Other researchers (e.g. Becker, 2000; Lim & Chai, 2008) have even argued that pre-service teachers with traditional pedagogical beliefs, even when placed in a technology-rich classroom may continue to use technology to support didactic or traditional skills-and-fact oriented

instructions. This implies that, for pre-service teachers to adopt technology for pedagogical purposes, there is a need for them to change their pedagogical beliefs from traditional behaviourist beliefs to a constructivist one.

However, Sandholtz & Reilly (2004) were of different opinion. They were of the view that some pre-service teachers may hold constructivist pedagogical beliefs, but may fail to perceive or take up the affordances of computer tools, because they may not be competent in using the technology, or because of the constraints of their socio-cultural contexts. This may be true in the Ghanaian pre-service teacher education context. In his study of 4 schools in Ghana, following 12 pre-service teachers in their beliefs in using computers as a tool for teaching and learning, a survey by Andam (2013) found that although 3 of the student teachers held constructivist beliefs, but they could not utilise the computers for pedagogical purposes due to a number of constraints, such as insufficient time to plan instruction, inadequate technical support, lack of leadership support and access to computers. However, he cited pressure from parents and the schools themselves, to ensure their pupils do well in the end-of-course examination, as the most significant constraint. The teachers and parents therefore, saw the use of computers for teaching and learning as "waste of time." This is consistent with the work of Cuban (2001), who bemoaned the fact that computers are oversold and underused. Cuban supported this assertion with his study in Silicon Valley schools in the United States. In his study he found that even though the teachers had access to computers, they used them for low-level tasks, such as online drill and practice that had no significant bearing on students' learning outcomes.

Complementing Andam's (2013) survey, the earlier study by Tonah (2006) found that the Ghanaian school curricula and the educational legislation for the past two decades placed the development of critical thinking among the priorities of formal education. However, in practice, teaching is still based on a teacher centred, didactic, very examination results' oriented approach. Given that the majority of the pre-service teachers in Ghana have been taught, and have been receiving their professional training, in the traditional learning environments, they tend to perceive teaching as disseminating information and learning as a passive activity, with students holding little responsibility for their own learning. Thus, having deep-rooted beliefs in teacher-centred learning, which is inconsistent with teaching with the use of computers (Angeli & Valanides, 2008), they may find it difficult to adopt computers for pedagogical purpose. As a consequence, to encourage pre-service teachers to adopt constructivist pedagogical beliefs when they become teachers, there is a need to engage them in examining and changing their traditional pedagogical beliefs.

Some researchers found that changing pre-service teachers' beliefs about teaching and learning with computers in the classroom has been found to be always a challenge (Lim & Chai, 2008); since their pedagogical beliefs are formed over many years of experiences, from life as pupils in the classroom (Richardson 2003) to the variety of professional contexts they encounter. However, Muijs and Reynolds (2003) argued that belief systems are dynamic mental structures that are susceptible to change by practical experiences. The teacher education programmes especially, at the pre-service stage, play a critical role in facilitating teachers' transformation in their instructional practices by shifting their pedagogical beliefs. However, if pre-service teacher education programmes merely teach learning theories and concepts, they are unlikely to have an effect on changing pre-service teachers' pedagogical beliefs and instructional practices (Kagan, 1992).

THEORETICAL FRAMEWORK

Various theories have been propounded to explore and explain the factors that cause individuals to accept, reject or continue with the use of new technology (Fishbein, & Ajzen, 2010; Venkatesh, 2000). Among these theories, the Technology Acceptance Model (TAM) has received intense and

growing educational and research interest over the last two decades (Al-Adwan & Smeldley, 2012; Al-Oteawi, 2012; Al-Somali, Ghalami & Clegg, 2009; Anandarajan, Igbaria & Anakwe, 2002; Buabeng-Andoh, 2012; Teo, 2009). The theory has also been adopted and tested in many empirical studies, and the tools used with the model have proven to be of consistent validity and yield statistically reliable results (Shroff, Deneen & Ng, 2011; Teo, 2009). Equally important, the model has been found to possess predictive validity in studies whose participants were pre-service teachers (Arcali & Saglam, 2015; Aypay et al., 2012; Luan & Teo, 2009; Teo, 2008; Wong, et al., 2013). Unfortunately, the model has not been used extensively and tested outside the advanced world, particularly within the African pre-service teacher educational context (Afari-Kuma & Achampong, 2010, Anamoah-Mensah, 2011; Farahat, 2012). Against this backdrop, the study adopts the TAM as a theoretical lens with which to study pre-service teachers' acceptance of computer technology in the Ghanaian pre-service teacher education context.

Originally propounded by Davis (1989), the TAM was developed to be utilised in predicting the acceptance of any information technology system, and to diagnose design problems before users actually use this system, through two salient factors which are: Perceived Usefulness (PU) and Perceived Ease of Use (PEU). Perceived Usefulness is defined as the degree to which a person believes that use of technology will produce better outcomes (Farahat, 2012). This suggests that if the pre-service teachers in this study perceive that employing computer technology can help enhance their performance in teaching, they are more likely to use it in their teaching practices. On the other hand, Davis (1989) posited that, PEU is the extent to which a user believes that using technology will be effortless. This is in line with pre-service teachers' perception about the degree of effort needed to utilise computer technology for teaching and learning purposes. The TAM postulates that higher levels of PU and PEU predict favourable attitudes which, in turn, predict Behavioural Intentions to use new technologies (Davis, 1989). While Attitude Towards Usage (ATU) is defined as the evaluative effect of negative or positive feeling of the individual in performing a particular behaviour (Ajzen & Fishbein, 2000), Behavioural Intention to Use (BIU) is defined as the extent to which a pre-service teacher formulates a conscious plan to use or not to use computer technology for teaching and learning purposes (Davis, 1989). The original TAM proposes that these three variables (PU, PEU and ATU) work together to impact the behavioural intention to use (BIU), which in turn influences the actual use of the technology in a given setting, as is shown in the figure below.

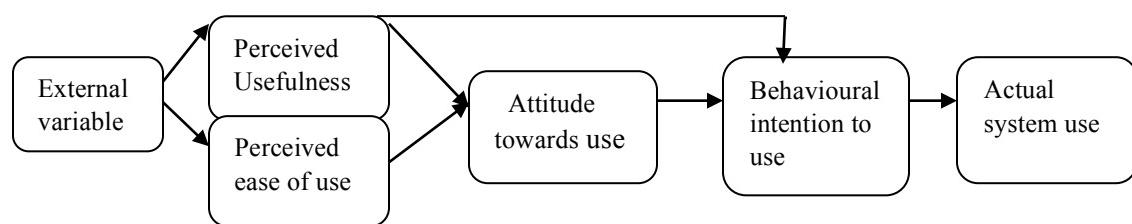


Figure: 1. The Technology Acceptance Model (TAM).

DEVELOPMENT OF HYPOTHESES

With its many extensions and refinements, the TAM has emerged as a leading scientific paradigm for investigating acceptance and usage of educational technology by teachers, student and other stakeholders in different contexts (Aypay, et al., 2012; Legris, 2003; Lule et al., 2012; Sanchez, et al., 2010; Teo, 2009; Wong et al, 2013). A study by Legris et al (2003) revealed that there is a need include other variables in order to provide a broader view and a better explanation of

technology adoption. A number of research studies have extended the model by adding external variables, such as self-efficacy (Davis, 1989; Wozney, Venkatesh & Abrami, 2006), pedagogical beliefs (Eteokleous-Grigorous, et al., 2012; Jimoyiannis, et al 2007), technological complexity (Teo, 2009), and technical support (Abbad et al. 2009), in order to strengthen the model.

Against this backdrop, this study extends the original TAM framework by adding pre-service teachers' pedagogical beliefs. The model used in this study focuses on examining direct effects between an exogenous variable (pedagogical beliefs) and four endogenous variables (perceived ease of use, perceived usefulness, attitude towards use and actual use of computer technology). Exogenous variables are not influenced by other variables without observed influences. The endogenous variables, in contrast, all have effects between them that are observed in the analysis. All the different variables, and the hypotheses derived from them are considered below:

Pedagogical Beliefs

Pre-service teachers' pedagogical beliefs have been viewed as a key area that needs to be addressed in the context of computer technology integration into classroom (Eteokleous-Grigorous, et al., 2012; Sipilä, 2010). Where pre-service teachers favour constructivist-oriented beliefs and student-centred approaches, they are more likely to use computers in their classrooms in a substantial and intellectually fruitful way (Jimoyiannis, et al., 2007; Ertmer, 2005). Many researchers are of the view that teachers' pedagogical beliefs and teaching philosophies influence the way technology is adopted and the degree of technology integration within classroom practices (Teo, et al., 2008; Luan & Teo, 2009; Judson, 2006), suggesting that the extent to which computers will be effectively integrated into pre-service teacher education instruction depends on the type of pedagogical perspective adopted by teachers. In this study it is hypothesised that:

Hypothesis 1. A pre-service teacher whose pedagogical practices favour constructivist-oriented beliefs and student-centred approaches is more likely to use computers with ease.

Hypothesis 2. A pre-service teacher whose pedagogical practices favour constructivist-oriented beliefs and student-centred approaches is more likely to find computers useful.

Perceived Usefulness

In this study perceived usefulness is defined as the degree to which pre-service teachers believe that adopting computer technology would promote their work performance in the school. There is evidence to suggest that pre-service teachers tend to use computers when they believe that it will enhance their job performance in the classroom (Teo, 2009; Teo & Schalk, 2009). This is grounded on the proposition that pre-service teachers would tend to utilize computers when such utilisation is useful in performing their educational tasks. In this context, the following hypotheses are proposed:

Hypothesis 3. Perceived usefulness will significantly and positively influence pre-service teachers' attitude towards use of technology.

Hypothesis 4. Perceived usefulness will significantly and positively influence pre-service teachers' actual use of computers.

Perceived Ease of Use

In this study PEU means the degree to a pre-service teacher believes using a computer will be free from effort. Venkatesh (2000) found PEU to be the primary driver in technology acceptance, adoption, and usage behaviour. Many research studies have also indicated that perceived ease of use has a positive impact on the attitude towards usage and behavioural intention (Luan & Teo, 2009; Teo, 2011). Luan & Teo (2009) find that perceived ease of use is a significant determinant of the attitude and intention to use technology among student teachers. Davis et al.,

(1989) also found that perceived ease of use is the dominant factor that influence perceived usefulness and this has been confirmed by recent studies (Teo, 2011; Sumark et al., 2011). In congruence with Davis (1989), Sumak et al. (2011) documented that perceived ease of use directly affects pre-service teachers' attitude. It is therefore hypothesised that:

Hypothesis 5. Perceived ease of use will significantly and positively influenced pre-service teachers' Perceived Usefulness.

Hypothesis 6. Perceived ease of use will significantly and positively influence pre-service teachers' attitude towards computer use.

Attitude towards Use

There is a growing research literature which suggests that attitudes towards computer use have a strong link to behavioural intention and therefore to actual behaviour (Davis, 1989; Luan & Teo, 2009; Sumark et al., 2011; Teo & Schalk, 2009). From the technology acceptance viewpoint, attitude towards use is a predisposition to respond favourably or unfavourably to the use of technology (Ajzen, 1991). Kersaint, Horton, Stohl, & Garofalo (2003) found that teachers who have positive attitudes towards technology feel more comfortable with using the technology, and usually incorporate it into their teaching. This implies that it is unlikely for the pre-service teachers with negative attitudes toward computer use be able to transfer their computer skills to their future students, let alone encourage their future students to use the technology (Yildirim, 2000). In the context of this study, it is reasonable to expect that pre-service teachers with positive attitudes toward the computer use are more likely to accept and use computers in the classrooms (Huang & Liaw, 2006; Teo, 2008).

Hypothesis 7. Attitude towards computer use will be positively and significantly influenced by pre-service teachers' actual computer use.

Actual System (ICT) Use

In the TAM, actual ICT use is the end result of all of the other constructs operating independently and interactively. The success of any form of technology provided by an educational institution in transforming the learning process depends on the willingness of the users to use it in performing their tasks. For this study, actual use was measured, based on a weekly usage scale, as well as pre-service teachers determined frequency of use range. It is important to note that this study did not consider the behavioural intention to use element, as the study focuses on the usage behaviour of computer technology by pre-service teachers. The figure 2 depicts the extended model.

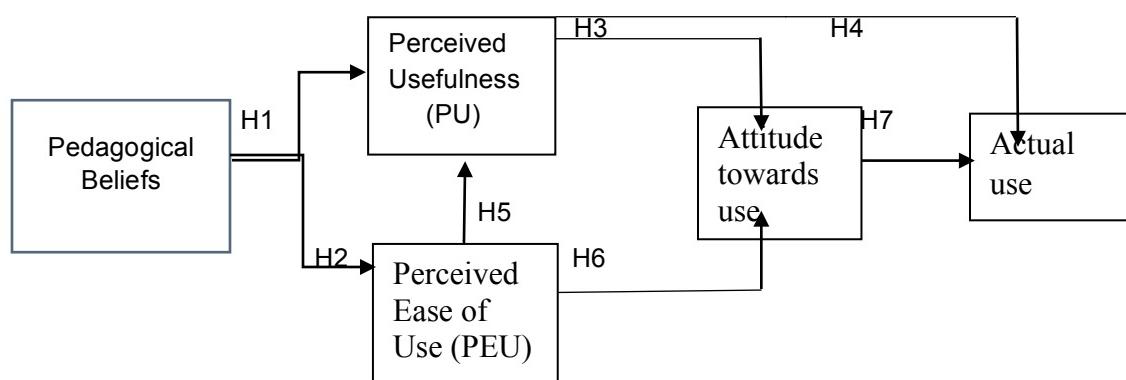


Figure 2: Research Model

METHODOLOGY

Context and participants

In order to empirically identify and test the proposed model, a questionnaire was randomly administered to 400 respondents in two pre-service teacher institutions in Ghana. From the 400 questionnaires, 380 usable responses were returned with response rate of 95%. There are two major categories of pre-service teacher institutions in Ghana. The first category is faculties of education in some designated universities in the country which train graduate teachers to teach in the senior high schools and colleges of education. The second category constitutes 38 colleges of education which train teachers to teach in the primary and junior high schools. The second category is the focus of this study for two reasons: First, they constitute over 75 percent of pre-service teachers in the country (Ministry of Education Statistics, (2011). Secondly, the use of modern information technologies are now integral part of basic schools in Ghana where these teachers are trained to teach.

Instrumentation

To provide a relevant data with the intention of providing meaningful answers to the research question, the study employed a quantitative, cross-sectional survey design aimed at collecting data for both descriptive and inferential statistical analyses purposes. The questionnaire was adopted from an existing validated questionnaire by Teo (2009) and other researchers. All the participating pre-service teachers were briefed on the purpose of the study and informed that they could withdraw their participation during, or after they had completed, the questionnaire. A self-reported questionnaire comprised 5 Likert-type items, with each item yielding a score of 1 (strongly disagree) to 5 (strongly agree) was used. These items were adopted from various published sources (Eteokleous-Grigorous, et al, 2012; Jimoyiannis, et al., 2007; Teo, 2009), as indicated in Table 1. (See Appendix 1). In addition to their demographic profiles, the pre-service teachers were required to answer 19 items, specifically relating to pedagogical beliefs (3), perceived usefulness (4 items), perceived ease of use (4 items), attitude towards computer use (4 items) and behavioural intention (4 items).

DATA ANALYSIS AND FINDINGS

The hypotheses were tested by employing IBM SPSS Statistical 21 software for descriptive and inferential analyses. The total number of valid surveys was 380 out of 400, giving a response rate of 95%. The majority of the respondents' age varied between 18 and 25, consisting of 51% females and 49% males. The highest proportion of respondents' was aged between 18–25 years old (85%) followed by 25-30 (15%). Pearson correlations analyses were conducted to gauge the strength of the relationship of the TAM constructs, while stepwise multiple regression analysis were conducted to test the hypotheses.

Pearson Correlation Analyses

In an effort to determine the strength and directions of the relationships among the various TAM constructs in the study, a Pearson correlation analysis was conducted. Table 1 shows Pearson correlation coefficients among dependent and independent variables within the TAM framework in this study. 6 out of the 7 correlations were significant and positively correlated. Statistically significant and strong positive correlations were found among ATU and ACU($r=.206, P<.000$); PU and ACU ($r=.118, P<.021$). Other statistically significant but moderate correlations were found among 4 important pairings: PB and PEU ($r= .111, P < .031$); PB and PU ($r = .110, P<.033$), PU and ATU ($r = .109, P < .034$); PEU and ATU ($r = .106, P < .039$); PEU and ATU ($r = .106, P <$

039). Perhaps, the most interesting results from the correlation analysis were the relationships that were insignificant. Contrary to expectations, a weak correlation was present between PEOU and PU ($r = .098$, $P > .056$) and as a result was rendered statistically insignificant. This is inconsistent with major TAM studies' (e.g. Davis, 1989; Teo, 2009) findings that found a strong link between PEU and PU. Based on the results of the correlation analyses a multiple stepwise regression analyses were conducted to test the hypotheses.

Table 1: Pearson's Correlation Coefficients among the TAM variables.

PATH	VALUE	SIGNIFICANCE
PU → ACU	.118*	.021
ATU → ACU	.206**	.000
PU → ATU	.109*	.034
PEU → ATU	.106*	.039
PEU → PU	.098	.056
PB → PEU	.111*	.031
PB → PU	.110*	.033

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

Hypotheses Testing

A multiple stepwise regression analysis was employed for hypotheses testing. According to Howitt & Cramer (2014) multiple regression quite simply helps us choose empirically the most effective set of predictors for any criterion. In this study, a series of stepwise multiple regression analyses were conducted to test the hypotheses. Each multiple stepwise regression analysis was between a set of independent variables and a single dependant variable. Following a standard practice in the Social Sciences research (Creswell, 2012), a statistical significant level of 0.05 (5%) was adopted as a benchmark to accept or reject a null hypothesis. According to Creswell (2012) the hypothesis is said to be statistically significant when the *p-value* (probability value) is less than the predetermined significant levels set by the researcher ($p < 0.05$). On the hand, *p-value* exceeding 0.05 (5%) value meant that there was no significant to the results obtained and the null hypothesis was rejected.

A stepwise multiple regression analysis in which Perceived Ease of Use was set as a dependent variable was conducted to test the first Hypothesis (H1).

Table 2: Influence of PB on PEU

Model	Unstandardized Coefficients		Beta	t	Sig
	B	Std. Error			
PB	.133	.052	.111	2.165	.031

a. Dependent Variable: Perceived Ease of Use (PEU)

b. Independent Variables (constant) Pedagogical Beliefs

Table 3 show that pedagogical beliefs (PB) has a significant influence on perceived ease of use (PEU) ($\beta=.111$, $P<.031$).

Table 3: Influence of PB and PEU on PU

Model	Unstandardized Coefficients		Standardised Coefficients	t	Sig
	B	Std. Error	Beta		
PB	.198	.092	.110	2.146	.033
*PEU	-	-	-	-	-

- a. Dependent Variable: Perceived Usefulness (PU)
- b. Independent Variable: (Constant), Pedagogical Beliefs (PB), Perceived Ease of Use (PEU).
- c. All PEU constructs deleted because of weak correlation between PEU & PU (see Table 1).

Results from Table 3 shows that pedagogical beliefs has a significant influence on perceived usefulness on computer use ($\beta = .110$, $P< 0.033$). Therefore, Pedagogical Beliefs impacts on pre-service teachers' perceived usefulness towards computer use. Consequently, hypothesis three (H: 2) is supported. Contrary to the expectations, the stepwise regression analysis deleted all the Perceived Ease of Use (PEU) constructs and therefore, could not be interpreted. This result contradicts the original TAM (Davis, 1989) that Perceived Ease of Use has a positive influence on Perceived Usefulness. Consequently, hypothesis three (H: 3) was not supported as it could not be interpreted.

Table 4: Influence of PU and PEU on ATU

Model	Unstandardized Coefficients		Standardised Coefficients	t	Sig
	B	Std. Error	Beta		
PU	.133	.052	.111	2.165	.031
PEU	.083	.041	.104	2.036	.042

- a. Dependent Variable: Attitude towards Use
- b. Independent Variables (constant)
- c. Perceived Usefulness (PU), Perceived Ease of Use (PEU).

Table 4 depicts that attitude towards computer use was found to be significantly and positively influenced by perceived usefulness and perceived ease of use. Hence, hypotheses 4 and 5 were supported.

Table 5: Influence of PU and ATU on ACU

Model	Unstandardized Coefficients		Standardised Coefficients	t	Sig
	B	Std. Error	Beta		
PU	.072	.031	.118	2.318	.025
ATU	.101	.027	.137	3.674	.000

- a. Dependent Variable: Actual Computer Use (ACU)
- b. Independent Variables (constant)
- c. Perceived Usefulness (PU), Attitude towards Use (ATU)

Table 5 indicates that both perceived usefulness (PU) ($\beta = .118$, $P < .025$) and attitude towards use (ATU) ($\beta = .137$, $P < 0.00$) had significant influence on Actual Computer Use (ACU). As a result H: 6 and H: 7 were supported.

Table 6: Summary of Hypotheses Testing Results

HYPOTHESES	PATH	HYPOTHESES	RESULTS
H1	PB → PEU	$P < .031$	SUPPORTED
H2	PB → PU	$P < .033$	SUPPORTED
H3	PEU → PU	$P > .056$	NOT SUPPORTED
H4	PEU → ATU	$P < .042$	SUPPORTED
H5	PU → ATU	$P < .031$	SUPPORTED
H6	PU → ACU	$P < .025$	SUPPORTED
H7	ATU → ACU	$P < .000$	SUPPORTED

As seen in Table 6, the results support all the hypotheses proposed in this study with the exception of hypothesis 3.

DISCUSSIONS AND CONCLUSIONS

Utilizing the TAM as theoretical framework, this study investigated the factors that influence pre-service teachers' technology acceptance and actual use of computers among pre-service teachers in Ghana. Based on multiple stepwise regression analyses, the results support all the seven hypotheses proposed in the study with the exception of hypothesis 3. Noteworthy findings were that, all the three key TAM constructs, perceived ease of use, perceived usefulness and attitude towards use, were found to have a significant positive direct and indirect influence on the pre-service teachers' actual use of computer technology for teaching and learning. These findings concur with research studies that suggest that positive and strong relationships among perceived ease of use, perceived usefulness and attitude towards computer use influence pre-service teachers' actual use of computer technology (Sumak et al., 2011; Teo, 2011).

Again, the study confirmed that the pedagogical beliefs of the pre-service teachers have a significant positive influence on both perceived ease of use ($\beta=111$, $P<.031$) and perceived usefulness ($\beta=110$, $P<.033$). This implies that the pre-service teachers' personal teaching philosophies directly influence their beliefs towards the ease of use and value (usefulness) of using computers as an educational tool. The confirmation of hypotheses one and two are in alignment with the widely held belief that, where pre-service teachers are in favour of constructivist beliefs and student-centred approach to teaching and learning, they are more likely to use computers in their future classrooms in a sustainable and intellectually fruitful way (Jimoyiannis et al., 2007; Judson, 2006; Ertmer, 2005).

On the contrary, a local study by Tonah (2006) found that pre-service teachers in Ghana develop their pedagogical beliefs through knowledge and skills they achieved through their previous education based on traditional way of teaching and learning in schools, and therefore, they would find it difficult to use computers for teaching and learning purposes. Therefore, if Tonah (2006)'s findings were true, then, it seemed to suggest that the pre-service teachers might have undergone fundamental shifts in their pedagogical beliefs to adopt constructivist approach towards their instructional practices. In effect, the pre-service teachers might have conceived the idea that through the use of computers, their future students can develop skills and abilities which are relevant to the 21st century and its challenges.

Inconsistent with the findings of other prominent TAM research studies (e.g. Davis & Venkatesh, 1996; Shroff, Deenen & Ng, 2011; Teo and Schalk 2009), the findings of this research indicated that, among the original TAM's key constructs, attitude towards use has the strongest positive statistical significant influence on the preservice teachers' actual use of computers ($\beta = .173$, $P <.000$) followed by perceived usefulness ($\beta = .118$, $P < .025$). This seemed in contradiction with other major TAM findings. For example, Venkatesh & Davis (1996) dropped the attitude towards use construct from the original model, as they concluded that it does not fully mediate the relationship between both perceived ease of use and perceived usefulness and behavioural intention to use.

Contrary to the expectations, perceived ease of use did not have a significant influence on usefulness of computers to the pre-service teachers. This is inconsistent with the prior TAM studies (Davis, 1989; Shroff et al., 2011; Sumark, et al., 2011; Teo, 2011; Wong & Teo, 2013) which found that perceived ease of use is a dominant factor in explaining perceived usefulness. However, the finding concurs with Hu et al., (1999) who found that perceived ease of use was not a significant determinant of perceived usefulness. A possible reason for this divergence could be that the pre-service teachers in the case study colleges may not see ease of use as a significant determinant of computer use, and therefore, adopt the technology primarily because of the functionality offered. It is also worthy to note that, pre-service teachers are not likely to use computers simply because they are easy to use, while it will not benefit them in their future job. Computers have been in the Ghanaian education system for over a decade, therefore, the pre-service teachers might have been relatively conversant with some of the advanced and complex technologies for personal and for teaching purposes, and preferred to be challenged when using computers for teaching and learning purposes.

In précis, this study extended the accepted TAM model by incorporating pre-service teachers' pedagogical beliefs and contributes to our understanding of pre-service teachers' acceptance of computer technologies for teaching and learning purposes. The findings from the data analysis confirm the influence of the renowned technology acceptance model variables such as pedagogical beliefs, perceived ease of use, perceived usefulness and attitude towards use on pre-service teachers' acceptance for computers for teaching and learning purposes. However, a contradiction surfaced within the model, as perceived ease had no significant influence on perceived usefulness.

CONCLUSIONS

Previous findings from the field of technology acceptance research documented that for the advantages of a technology to be attained, the technology must be accepted and used (Venkatesh et al., 2003). The aim of this current study was to investigate the factors that influence technology acceptance and use of computers among pre-service teachers in Ghana. This aim was accomplished by extending the original technology acceptance model by adding pre-service teachers' pedagogical beliefs as an exogenous variable.

Given the pertinence of computer usefulness in relation to technology acceptance, pre-service teacher educational programmes, especially, those in Ghana should enhance pre-service teachers' knowledge and beliefs on the usefulness of computers in teaching and learning. Achieving this, there should be visible and effective leadership (principals, teacher educators and others) involvement in the use of the technology for teaching and learning purposes. Seeing the leadership leading by example, will encourage the pre-service teachers to see the importance of using the computers for teaching and learning purposes. Similarly, the teacher educators can increase the pre-service teachers' level of computer usefulness by demonstrating the usefulness of computer in their daily instructional process. This will motivate the pre-service teachers to

accept and use the computers for teaching and learning purposes, since there will be modelling for them to follow. In addition, the pre-service teachers should be given adequate access to computers in both classrooms and computer labs. Limiting access to computer labs only, as in the two case study pre-service teacher institutions in this study, does not encourage pre-service teachers to use computers effectively.

In every technology implementation process, the involvement of teachers is crucial and therefore, the knowledge about the pre-service teachers' attitude towards the implementation is a key element to successfully guide the process of adoption of new technologies into teaching practice. Against backdrop, efforts should be made to encourage more positive computer attitudes among pre-service teachers, since the findings of this study indicated that attitude has the strongest significant impact on pre-service teachers' acceptance of technology. A noteworthy finding in the study is that pre-service teachers' pedagogical beliefs have a significant direct effect on both PU and PEU and indirect effect on attitude to use, as well as the intention to use. Given that the pre-service teachers in this study attended schools where direct instruction and examination dominated the learning environment, they are more likely to hold on to the traditional pedagogical beliefs which are incompatible with the adoption of computers for pedagogical purpose. Therefore, to support the pre-service teachers in perceiving and taking up the affordances of computer tool, there is a need to organise relevant continuous professional development programmes to engage the pre-service teachers in constructivist-learning experiences in computer-mediated classrooms. Thus, pre-service teacher education programmes need to be redesigned to provide the pre-service teachers with pedagogical approaches that go beyond the current traditional lecture-recitation-seat-work model. In a similar vein, the teacher educators need in-depth, sustained assistance to incorporate computer technology into the curriculum and reconcile new methods of instruction which use technology extensively with non-traditional methods. Building their competencies in computer usage, will also help the pre-service teachers to develop positive attitudes towards computer use.

Looking Ahead

Despite the positive findings that the TAM is a predictive and robust model, this study is not without limitations. Two key limitations were identified: First, the study relied on a sample of pre-service teachers from only two public pre-service teacher educational institutions, out of 38 in Ghana. Furthermore, the sample size of 380 is relatively small. Taken together, these factors limit the ability to generalise the results of this study to a wider population of pre-service teachers in Ghana. The study needs to be replicated with other pre-service teachers, especially those in the faculties of education in the universities in Ghana.

In addition to the pedagogical beliefs adopted as an external construct, efforts to search for other relevant external constructs should be encouraged to make the TAM more fruitful. Variables such as leadership support, technical support, age and access can be added. The incorporation of these factors could improve the prediction capacity of the model. Also, from methodological perspective, future studies may need a methodological shift in order to gain richer understanding of less studied factors. So far, nearly all the prior studies adopt a quantitative research methodology. Qualitative methodology based on an interpretive perspective, which is more informative, may be a useful alternative that can give researchers a new insight (Creswell, 2014). In addition, this study analysed pre-service teachers' behavioural intention at a single point in time; consequently, it is recommended to carry out a similar longitudinal study, since individual perceptions change over time. As technology continues to grow and develop rapidly, replication of this study should be conducted periodically, in order to examine educational technologies trends to update and provide appropriate knowledge and skills for pre-service as well as in-service teachers.

The study provides a new theoretical model which extends the original TAM by incorporating pedagogical beliefs, a construct that has been relatively unexplored in the previous TAM studies, which has shown interesting results in this study. The findings of this study have added to the literature of the research and practice of educational technology development in the Ghanaian context in particular, and in the developing world in general. The findings of the study support the prior research studies that found that the TAM is powerful, highly reliable, valid and robust predictive model that may be adopted in various contexts.

REFERENCES

- Abbad, M. M., et. al., (2009). Looking under the bonnet: factors affecting student adoption of e-learning systems in Jordan. *International of Research in Open and Distance Learning*. 10(2), 1-25.
- Adams, C. (2005). *The teacher learning academy – transforming teaching and learning through teacher learning*. Retrieved July 14, 2015, from <http://www.gtce.org.uk/Newsfeatures/features/tlaspeech>.
- Adu Gyamfi, S. (2011) *Using ICT to Re-engineer Initial Teacher Education in Ghana*. Unpublished MPhil Thesis. University of Southampton.
- Afari-Kuma, E., & Achampong, K. E. (2010). Modelling computer usage intentions of tertiary students in a developing country through the Technology Acceptance Model. *International Journal of Education and Development using Information and Communication Technology (IJDICT)*, 6(1), 102-116.
- Ajzen, I. & Fishbein, M. (2000). Attitudes and the attitude-behaviour relation: Reasoned and automatic processes. *European Review of Social Psychology*, 11, 1-33.
- Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and Human Decision Processes*, 50, 179-211. doi: 10:1016/0749-5978(90020-T).
- Al-Adwan, A. & Smeldley, J. K. (2012). "Implementing e-learning in the Jordanian Higher Education Systems: Factors affecting impact". *International Journal of Education and Development using Information and Communication Technology*, 8 (1), pp. 121-135.
- Al-Oteawi, S. M. (2012). *The perceptions of Administrators and teachers in utilizing information technology instruction, administrative work, technology planning and staff development in Saudi Arabia*. Doctoral dissertation, Ohio University.
- Al-Somali, S. A., Ghalami, R., & Clegg, B. (2009). An investigation of online banking in Saudi Arabia, *Technovation*, 29, 130-141.
- Anamoah-Mensah, S. (2011). "T141-ID Using the Technology Acceptance Model to predict Ghanaian Students Acceptance and Adoption of Mobile learning." *Paper presented at the annual meeting of the AECT International Convention*, Hyatt Regency Jacksonville Riverfront, Jacksonville, FL.
- Anandarajan, M., Igbaria, M., & Anakwe, U., (2002). IT acceptance in a Less-Developed Country: A motivational factor perspective, *International Journal of Information Management*, 22 (1), 147-634.

- Andam, K. (2013). *Teaching with computers; Prospective teachers' pedagogical beliefs*. Kumasi: Afram Publications.
- Angeli, C., & Valanides, N. (2008). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT-TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers & Education*, 52(1), 154-168.
- Arcali, D. S. & Salam, Y. (2015). Investigation of pre-service teachers' intention to use social media in teaching activities within the framework of technology acceptance model. *Procedia – Social and Behavioural Sciences*, No.176, pp.709-713. Retrieved 12 September 2015 from:
www.sciencedirect.com
- Asian Development Bank (ADB). (2008). Education and Skills. Strategies for Accelerated Development in Asia and Pacific. Manila ADB retrieved 28 May 2015 from:
www.adb.org/Documents/Studies/Education-skills-strategies-Development/Education-Skills/Strategies-Developmentpdf
- Aypay, A. et al., (2012). Technology acceptance in education: A study of pre-service teachers in Turkey. *The Turkish Online Journal of Educational Technology*. Vol. (11) issue 4, pp264-272.
- Becker, H. J. (2000). Findings from the teaching, learning, and computing survey, Is Larry Cuban right? *Education Policy Analysis Archives*, 8(51), Retrieved December 18, 2015 from <http://epaa.asu.edu/epaa/v8n51/>.
- Buabeng-Andoh, C. (2012). Factors influencing teachers' adoption and integration of information and communication technology into teaching: A review of the literature. *International Journal of Education and Development using Information and Communication Technology*, 8(1), 136-155.
- Chai, C. S., Teo, T., & Lee, C. B. (2010). Modelling the relationships among beliefs about learning, knowledge, and teaching of pre-service teachers in Singapore. *The Asia-Pacific Education Researcher*, 18(1), 117-128.
- Creswell, J. W. (2014). *Educational Research: Planning, Conducting and Evaluating Quantitative and Qualitative Research (Fourth Edition)*. Pearson New International Edition.
- Cuban, L. (2001). *Oversold and underused: computers in the classroom*. Cambridge, MA: Harvard University Press.
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13, 3, 319–339.
- Davis, F. D., Bagozzi, R. & Warshaw, P. (1989). "User Acceptance of Computer Technology: A comparison of Two Theoretical Models." *Management Science*, 35 (8), pp. 982-1003.
- Davis, F. D. & Venkatesh, V. (1996). A critical assessment of potential measurement biases in the technology acceptance model: three experiments. *International Journal of Human-Computer Studies*, 145, 19-45.
- Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research & Development*, 53(4), 25-39.

- Ertmer, P.A., Addison, P., Lane, M., Ross, E., & Woods, D. (1999). Examining teachers' beliefs about the role of technology in the elementary classroom. *Journal of Research on Computing in Education*, 32(12), 54-72.
- Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher Technology Change: How Knowledge, Confidence, Beliefs, and Culture Intersect. *Journal of Research on Technology in Education* Vol. 42, no. 3, 255-284. Retrieved 13 January 2014 from: www.iste.org/jrte.
- Eteokleous-Grigorous, N., Anagnostou, G., & Tsolakidis, S. (2012). *Examining the Use of Text Corpora and Online Dictionaries as Learning Tools: Pre-Service Teachers' Perspectives*. Springer: New York.
- Farahat, T. (2012). Applying the Technology Acceptance Model to Online Learning in the Egyptian Universities. *International Educational Technology Conference IETC, 2012: Procedia-Social & Behavioural Sciences*, 64, pp.95-104.
- Fishbein, M., & Ajzen, I. (2010). *Predicting and changing behaviour: The reasoned action approach*. New York: Psychology Press (Taylor & Francis).
- Hammond, M. (2011). Belief and ICT: what can we learn from experienced educators? *Technology, Pedagogy and Education*, 20:3, 289-300.
- Hermans, R., Tondeur, J. van Braak, J., Valcke, M. (2008). The impact of primary school teachers' educational beliefs on the classroom use of computers. *Computers and Education*, 51(4): 1499-1509.
- Howitt, D., & Cramer, D. (2014). *Introduction to Statistics in Psychology with SPSS* (6TH ed.). Harlow: Pearson.
- Hu, P. J., Chau, P. Y., Liu, S. O. R., & Tam, K. Y. (1999). Examining the technology acceptance model using physician acceptance of telemedicine technology. *Journal of Management Information Systems*, 16, 91-112.
- Huang, H. M. & Liaw, S. S. (2006). Exploring users' attitudes and intentions towards the Web as a survey tool. *Computers in Human Behaviour*, 2(5), 727-743.
- Jimoyiannis, A., & Komis, V. (2007). Examining teachers' beliefs about ICT in education: implications of a teacher preparation programme, *Teacher Development*, 11(2), 149-173.
- Judson, E. (2006). How teachers integrate technology and their beliefs about learning: Is there a connection? *Journal of Technology and Teacher Education*, 14, 581-597.
- Kagan, D. M. (1992). Implications of research on teacher belief. *Educational Psychologist*, 27(1): 65-90
- Kersaint, G., Horton, B., Stohl, H., & Garofalo, J. (2003). Technology beliefs and practices of mathematics education faculty. *Journal of Technology and Teacher Education*, 11(4), 549–577.
- Legris, P., Ingham, J. & Collerette, P. (2003). Why do people use information technology? A critical review of the technology acceptance model, *Information Management*. 40 (3), 191-204.

- Lim, C. P., & Chai, S. C. (2008). Teachers' pedagogical beliefs and their planning conduct of computer-mediated classroom lessons: *British Journal of Educational Technology* 39 (5) 807-828.
- Lim, C.P. & Khine, M. S. (2006). Managing teachers' barriers to ICT integration in Singapore schools. *Jl. Of Technology and Teacher Education*, 14(1), 97-125.
- Lim, C. P., Lock, G. & Brook, C. (2011). *Innovative Practices in Pre-service Teacher Education: An Asia Pacific Perspective*, Sense Publishers.
- Luan, W. S. & Teo, T. (2009). Investigating the technology acceptance among student teachers in Malaysia: An application of the technology acceptance model (TAM). *The Asia Pacific Education Researcher*, 18(2), 261-272.
- Lule, I., Omwansa, T. & Waema, T. (2012). "Application of Technology Acceptance Model in M-Banking Adoption in Kenya," *International Journal of Computing and ICT research*, 6(1), 31-34.
- Miller, S., Maier, E., Payne-Bourcy, L., Shablak, S., Newman, D., Wan, T. W., Casler, E. C., et al., (2003). *Technology as catalyst for change: A leadership model for transforming urban teacher programmes*. Presented at the American Educational Research Association, Chicago, IL.
- Ministry of Education Statistics, (2011). *Demographic Characteristics of Ghanaian Teachers*. Accra, MOE.
- Muijs, D., & Reynolds, D. (2003). Teachers' beliefs and behaviours: What really matters? *Journal of Classroom Interaction*, 37(2), 3-15.
- Pajares, M. F., (1992) Teachers' Beliefs and Educational Research: Cleaning up a Messy Construct, *Review of Educational Research*, 62(3): 307-332.
- Richardson, V. (2003). Pre-service teachers' beliefs. In J. Rath & A. C. McAninch (Eds.), *Teacher beliefs and classroom performance: The impact of teacher education* (pp. 1–22). Greenwich, CT: Information Age Publishing.
- Russell, M., Bebell, L. O'Dwyer, and L O'Connor, (2003). Examining teacher technology use. Implications for pre-service and in-service teacher preparation. *Journal of Teacher Education*. 54, no. 4: 297-310.
- Sánchez, R. A., & Hueros, A. D. (2010). Motivational factors that influence the acceptance of Moodle using TAM. *Computers in Human Behaviour*, 26, 1632-1640.
- Sandholtz, J. H. (2001). Learning to teach with technology: A comparison of teacher development programs. *Journal of Technology and Teacher Education*, 9(3), 349-374.
- Sandholtz, H. M. & Reilly, B. (2004). Teachers, not technicians: rethinking technical expectations for teachers. *Teachers College Record*, 106, 3, 487-512.
- Shroff, R. H., Deneen, C. C. & Ng, E. M. W. (2011). Analysis of the technology acceptance model in examining students' behavioural intention to use an e-portfolio system. *Australian Journal of Educational Technology*, 27(4), 600-618. Retrieved 3rd January 2015 from: <http://www.ascilite.org.au/ajet/ajet27/shroff.html>.

- Sipilä, K. (2010). "The impact of laptop provision on teacher attitudes towards ICT", *Technology, Pedagogy and Education*, 19: 1, 3-16.
- Šumak, B., Heričko, M., Pušnik, M., & Polančič, G. (2011). Factors affecting acceptance and use of Moodle: An empirical study based on TAM. *Informatica*, 35, 91-100.
- Teo, T. (2011). Factors influencing teachers' intention to use technology: Model development and test. *Computers & Education*, 57(4), 2432-2440. Retrieved 18th March 2014 from: <http://dx.doi.org/10.1016/j.compedu.2011.06.008>.
- Teo, T (2009). Modelling technology acceptance in education: A study of pre-service teachers. *Computers & Education*. 52(2009) 302-312.
- Teo, T. (2008). Pre-service teachers' attitudes towards computer use: A Singapore survey. *Australian Journal of Educational Technology*, 24(4), 413-424.
- Teo, T., Chai, C.S., Hung, D. & Lee, C.B. (2008). Beliefs about teaching and learning and uses of technology among pre-service teachers. *Asia Pacific Journal of Education* 36(2), 165-176.
- Teo, T. & Schalk, P. (2009). "Understanding technology acceptance in pre-service teachers: A structural-equation modelling approach". *The Asia-Pacific Education Researcher*, 18 (1), pp. 47-66.
- Tonah, S. (2006). *The Unending Cycle of Education Reforms in Ghana*. Paper presented at the African Students Association, Frankfurt, Germany: 24-27 March 2006.
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F.D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425 – 478.
- Venkatesh, V. & Davis, F.D. (2000). "A theoretical extension of the technology acceptance model: four longitudinal field studies," *Management Science*, Vol. 46 (2) pp. 186-204.
- Venkatesh, V., & Davis, F.D. (1996). A model of the antecedents of perceived ease of use: Development and test. *Decision Sciences*, 27(3), 451-481.
- Wong, T. W. et al. (2013). Understanding student teachers behavioural intention to use technology: *Technology acceptance model (TAM) validation and testing*. Vol.6, No.1. pp. 90-104.
- Wozney, L., Venkatesh, & Abrami, P. (2006). Implementing computer technologies: Teachers' perceptions and practices. *Journal of Technology and Teacher Education*, 14 (1), 173-207.
- Yildirim, S. (2000). Effects of an educational computing course on pre-service and in-service teachers: A discussion and analysis attitudes and use. *Journal of Research on Computing in Education*, 32(4), 479-495.

APPENDIX 1

VARIABLES	QUESTIONS	ITEMS	SOURCE
Pedagogical Beliefs (PB)	Using ICT helps me focusing on constructivist practices and student-centred approaches Using ICT provides opportunity for me to collaborate with my peers. I can use ICT to encourage students take the responsibility of their own learning	PB1 PB2 PB3	Eteokleous-Grigorous, et al., 2012
Perceived Usefulness (PU)	Using computers will improve my work Using computer will improve my effectiveness Using computers will improve my productivity. I find computers a useful tool for my work	PU1 PU2 PU3 PU4	Teo (2009)
Perceived Ease of Use (PEOU)	I find it easy to use ICT to do all that I want to do, with respect to teaching and learning. It is easy for me to become skilful at using ICT for teaching. Using ICT for teaching requires a lot of mental effort. Overall I find ICT easy to use in my teaching	PEU 1 PEU 2 PEU 3 PEU 4	Teo (2009)
Attitude Towards Use (ATU)	Computers makes work more interesting I like using computers I look forward to those aspects of my job that require me to use computers Working with computers is fun	ATU1 ATU2 ATU3 ATU4	Teo (2009)
Actual Computer Use	I use computer for teaching and learning I use computer for administrative work I use computer for communication I use computer for searching information	ACU1 ACU2 ACU3 ACU4	Teo (2009)

Copyright for articles published in this journal is retained by the authors, with first publication rights granted to the journal. By virtue of their appearance in this open access journal, articles are free to use, with proper attribution, in educational and other non-commercial settings.

Original article at: <http://ijedict.dec.uwi.edu/viewarticle.php?id=2090>